Restoration, Rocks & Rivers

Monitoring And Modeling of Biological Impacts:

What Can We Really Say Regarding Benefits?

(Not that I pretend to know the answer….)

Paul DeVries

R2 Resource Consultants

Talk Strategery…

- **Ways on how data are processed to say something about biological impacts of a "restoration" project (fish-centric)**

- **How much should we read into model predictions and monitoring data to justify a project being called a success?**

- **How much monitoring can we (and actually) do? Examples from Washington State**

- **Are there alternative ways to increase reproductive success?**

Modeling Impacts of a Restoration Project

- **What relevant features 'can' we model?**
  - Spawning habitat availability
  - Bed stability
  - Fine sediments
- **What is 'best' model?**
  - Do we really need another model?

- **Models are typically offered to:**
  - Identify restoration needs and opportunities
    - Broad characterization vs. specific feasibility
  - Calculate effects on survival & production
    - Absolute
    - Relative

Examples of Pacific Northwest Models Used to Predict Biological Effects….

- **EDT**

  - **Ecosystem Diagnosis and Treatment**

Examples of Pacific Northwest Models Used to Predict Biological Effects….

- **EDT**
  - **E**cosystem **D**iagnosis and **T**reatment?

    or
  - **E**xtreme **D**ata **T**ampering?

Examples of Pacific Northwest Models Used to Predict Biological Effects….

- **EDT**
  - **E**cosystem **D**iagnosis and **T**reatment?

    or
  - **E**xtreme **D**ata **T**ampering?

- **Shiraz**

- **Both involve Beverton-Holt principles**
  - Productivity
    - Mortality forces imposed by bed scour, fine sediments
  - Carrying Capacity
    - Comes down to spawning habitat quantity

EDT and Shiraz

- **Effective Goal: Evaluate effects of anthropogenic changes in habitat conditions (e.g., spawning gravel supply, stability, and quality) on production**

- **Many knobs and levers**

- **Intensive data inputs**

- **Predictive ability in question**
  - Poor quality data may be used, good quality data may be ignored if the model doesn't predict well using those data
  - Autocorrelations likely

- **Differing perception of model capabilities between managers and scientists**

Applying Ecosystem Models to Gravel Augmentation Projects

- **Need to differentiate between:**
  - Increasing spawning habitat area
  - Increasing spawning habitat quality

Applying Ecosystem Models to Gravel Augmentation Projects

- **Need to differentiate between:**
  - Increasing spawning habitat area
  - Increasing spawning habitat quality

- **"Survivals" assumed independent**
  - productivity = $fn(S_1 \times S_2 \times \dots \times S_n)$

- **Have to also consider project in larger ecosystem context**
  - Does effect of project matter in view of other mortality forces?
  - But, with so many knobs and levers, are ecosystem models self-defeating for evaluating biological effects of gravel augmentation because of the large prediction error?

Models Need Data

- **For evaluating effects of gravel augmentation, models will likely rely on metrics such as peak flow, depth of scour, percent fine sediments, amount of usable spawning habitat, but how should we represent these?**

- **And are we asking the right question regarding measurements?**
    - **E.g. Habitat availability: 1D vs. 2D vs. "EHM"**
        - *Not:* **Which method is more "accurate"**
        - *Instead:*   **What is the most relevant conclusion?**

Habitat Quality Example Relevant to Gravel Augmentation: Bed Scour in EDT

- **Classify a stream reach in terms of average scour depth in spawning areas during the annual peak flow event over a ~10 year period (ASD), and effectively use this ranking to determine a model 'survival':**

  - Index 0 → 0 < ASD < 2 cm
  - Index 1 → 2 < ASD < 10 cm
  - Index 2 → 10 < ASD < 18 cm
  - Index 3 → 18 < ASD < 24 cm
  - Index 4 → 24 < ASD < 40 cm

Habitat Quality Example Relevant to Gravel Augmentation: Bed Scour in EDT

- **Models assume some functional relationship between survival and scour depth**
  - Scour depth or survival typically assumed to be predictable based on peak flow (Shiraz was looking at flood recurrence interval…)
  - Mechanics of scour still poorly described
  - Biological responses to a specific scour depth still not well-described

Habitat Quality Example Relevant to Gravel Augmentation: Bed Scour in EDT

- **Models assume some functional relationship between survival and scour depth**

  - Scour depth or survival typically assumed to be predictable based on peak flow (Shiraz was looking at flood recurrence interval…)

  - Mechanics of scour still poorly described

  - Biological responses to a specific scour depth still not well-described

  - **Larger question is, how predictive is the (or any) model really?**

To Model or to Monitor?

- **To determine benefits, may be best to treat selected augmentation project(s) as a field scale experiment, rather than depend on ecological models or laboratory studies?**

To Model or to Monitor?

- To determine benefits, may be best to treat selected augmentation project(s) as a field scale experiment, rather than depend on ecological models or laboratory studies?

- If money becomes an issue, should we:

  - Start new augmentation projects, or

  - Focus on existing projects and collect long term, meaningful measurements of biological effects through monitoring?

But Monitoring Is Haaaarddd…

- **Data collection can be back-breaking in this field**

- **Can take a lot to get that one, <u>good</u> data point**

- **Treat it with respect before and after!!!**

- **And, always need to ask:**
  - **Am I measuring what I think I'm measuring?**

Typical Monitoring Data: What Conclusions Can We Really Draw From A Measurement?

- Scour depth
- Fine sediment levels/intrusion rate
- Grain size distribution
- Bedload transport rate
- Tracers
- Cross Sections
- Velocities
- Bathymetry
- Permeability

- Redd counts
- Fry/juvenile densities
- Spawner counts
- Carcass counts
- Cover usage
- Habitat mapping
- Macroinvertebrates
- Spawner distribution
- Embryo Mortality

The Challenge Remains: Linking Biological Effects to Physical Changes or Events Through Monitoring

- **What should I measure? Depth of scour, fine sediment intrusion rate, grain size distribution, bedload transport rate? Why?**

- **How should I measure it?**

- **What is best way to relate it to a biological effect?**
    - **Mechanistic vs. Correlation**
    - **Practical vs. Ivory Tower**

- **We're still struggling along trying to answer these questions….**

- **Collective monitoring experience important**

Monitoring and the Washington State Salmon Recovery Funding Board (SRFB)

- **Funding habitat <u>projects</u> that protect, preserve, restore and enhance salmon habitat and watershed functions**

- **Funding <u>activities</u> that are integral to protecting or improving salmon habitat**

SRFB Criteria

- **Evaluate projects, acquisitions, and assessments in terms of:**
  - **Benefits to Salmon**
  - **Certainty of Success**
    - **Project completion/operation**
    - **Achieving purported benefits to salmon**

- **Evaluate assessments also in terms of:**
  - **Will the assessment lead directly to project(s)?**
    - (or just another bound document?)

Monitoring of SRFB-Funded Projects
http://www.iac.wa.gov/

- **SRFB presently funding a 2+ year study of a range of projects and acquisition:**
  - **Implementation**
    - *Was project completed as proposed?*
    - *How closely were designs/criteria followed?*
  - **Effectiveness**
    - *Did project survive and work as designed?*
    - *Did project result in positive changes to habitat?*
  - **Validation**
    - *Did project increase net production? Or just move fish around?*
    - *i.e., Did project result in meaningful changes in habitat?*

Monitoring of SRFB-Funded Projects
http://www.iac.wa.gov/

- **Study initiated in response to limited monitoring by project sponsors**
  - *Mostly implementation!*

- **Evaluating sample size issues**
  - Substituting space for time

- **Not entirely sure what measurements to make and why**
  - Everyone wants to write another monitoring protocol….are we waiting for Godot?
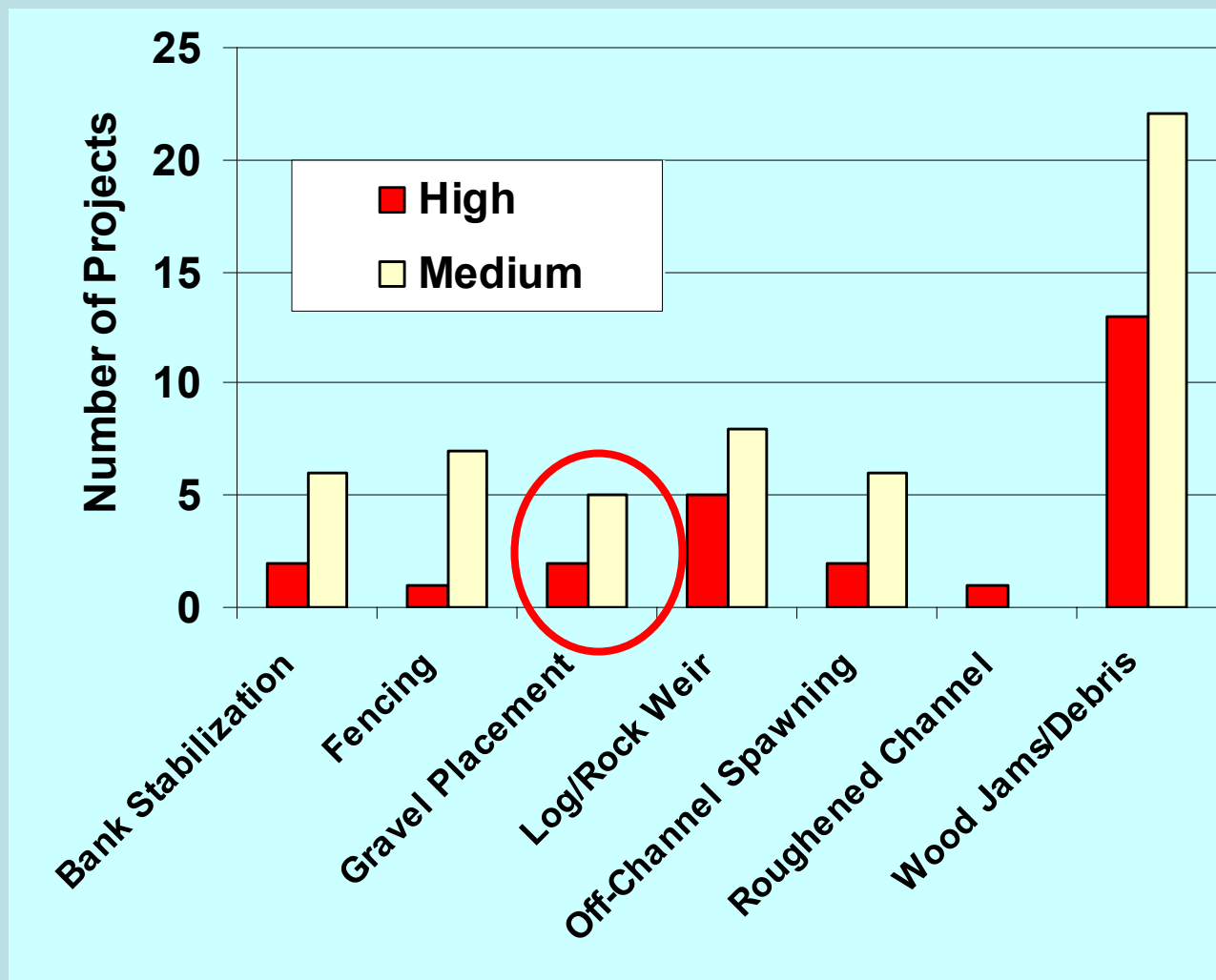
Monitoring of SRFB-Funded Projects
http://www.iac.wa.gov/

- **Study initiated in response to limited monitoring by project sponsors**
  - *Mostly implementation!*

- **Evaluating sample size issues**
  - Substituting space for time

- **Not entirely sure what measurements to make and why**
  - Everyone wants to write another monitoring protocol….are we waiting for Godot?

- **Overriding Question: Is the money being spent well?**

Instream Projects Funded by SRFB To Improve Spawning Habitat

- Bank Stabilization
- Spawning Gravel
- Log Jams/LWD
- Log/Rock Control (Weir)
- Livestock Fencing
- Off-Channel Habitat
- Roughened Channel

Technical Panel Evaluation of Funded Projects: Benefits to Salmon

Technical Panel Evaluation of Funded Projects: Certainty of Success
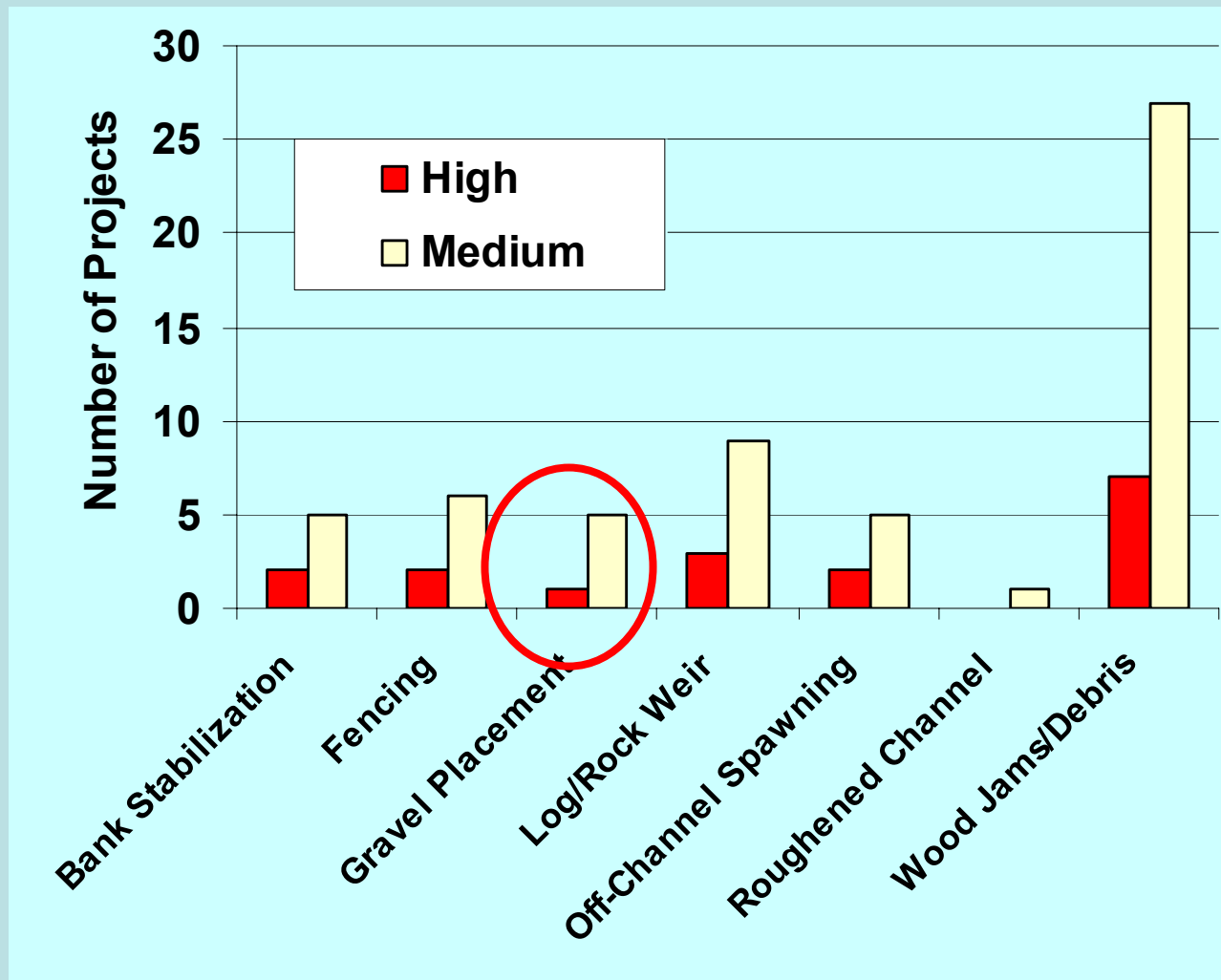
Survey of SRFB Project Monitoring to Date

Monitoring Plans of Funded Projects

–**Survey Found:**

- **46% of Projects Had a Written Monitoring Plan**

- **56% of Those Projects Had Submitted Plan to IAC**

- **Most Monitoring Funds From Other Sources**

Benefits=???

- Monitoring Appears to be Mostly of Implementation

- Limited Effectiveness Monitoring
  - Redd/Fry Surveys
  - Habitat Characterization

- Anecdotal/Visual

Spawning Gravel

- Little to no Monitoring
  - Add more later?
  - Scour and fill?
  - Redirection From Other Areas?
  - No Excessive Siltation
  - Spawning & Fry Monitoring Most Common

- First Use Within 1-3 Years of Implementation

- Too Soon to Tell if System Production Has Increased as a Result – Need Many Years of Data

Are There Alternatives to Gravel Augmentation Suggested By Biological Monitoring?

- **Example: Passage Barrier Removal In Washington State**

- **Average Costs:**
  - **Habitat:**
    - **$234,000/Project**
  - **Passage:**
    - **$292,000/Project**
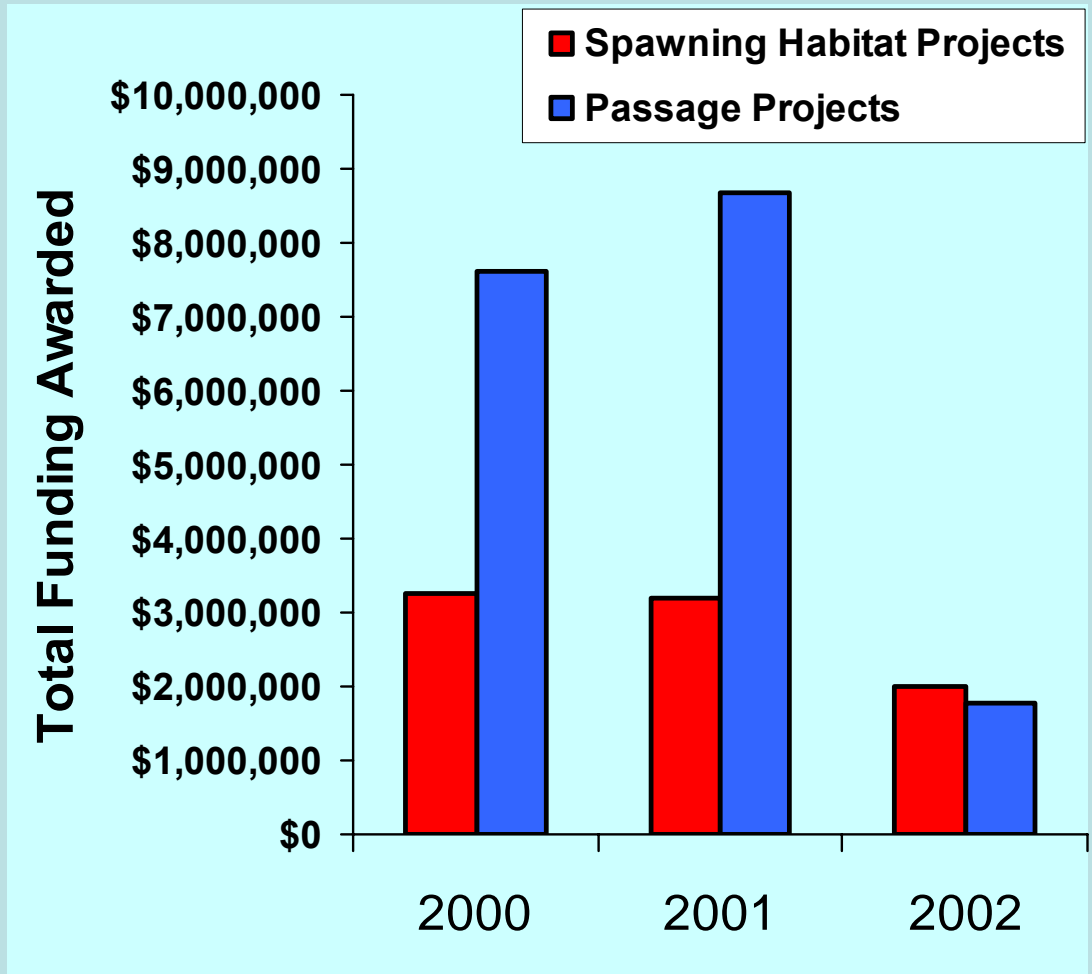
Opening Blocked Habitat

- Can be more expensive than gravel augmentation (although I guess that can depend on the project....), and depend more on future water availability and politics in CA than in WA

  But:

- Often more 'Bang For Buck'
- More assured of benefits
  - Spawning habitat access
  - Can be longer term fix
- Are there overlooked opportunities in tributaries of major rivers where augmentation is proposed or has been done?

"*Mon Dieu*, this gravel has a certain *je ne sais quoi*…"

© 1998-1999 E.R. Keeley